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Insect Migration at Rancho Grande in North-central Venezuela. General Account.[1]

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(Plates I & II; Text-figure 1).

[This is one of a series of papers resulting from the 45th, 46th and 47th Expeditions of the Department of Tropical Research of the New York Zoological Society, made during 1945, 1946 and 1948, under the direction of Dr. William Beebe, with headquarters at Rancho Grande in the National Park of Aragua, Venezuela. The expeditions were made possible through the generous cooperation of the National Government of Venezuela and of the Creole Petroleum Corporation.

[The characteristics of the research area are in brief as follows; Rancho Grande is located in north-central Venezuela (10° 21′ N. Lat., 67° 41′ W. Long.), 80 kilometers west of Caracas, at an elevation of 1,100 meters in the undisturbed montane rain forest which covers this part of the Caribbean range of the Andes. The migration flyway of Portachuelo Pass, which is also the water-shed between the Caribbean and Lake Valencia, is 200 meters from Rancho Grande. Adjacent ecological zones include seasonal forest, savanna, thorn woodland, cactus scrub, the fresh-water lake of Valencia and various marine littoral zones. The Rancho Grande area is generally subtropical, being uniformly cool and damp throughout the year because of the prevalence of the mountain cloud cap. The dry season extends from January into April. The average humidity during the expeditions, including parts of both wet and dry seasons, was 92.4%; the average temperature during the same period was 18° C; the average annual rainfall over a five-year period was 174 cm. The flora is marked by an abundance of mosses, ferns and epiphytes of many kinds, as well as a few gigantic trees. For further details see Beebe and Crane, *Zoologica*, Vol. 32, No. 5, 1947. Unless otherwise stated, the specimens discussed in the present paper were taken in the montane cloud forest zone, within a radius of one kilometer of Rancho Grande.]

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[1] Contribution No. 843, Department of Tropical Research, New York Zoological Society.

GENERAL ACCOUNT.

Throughout the first year of our occupation of the station at Rancho Grande in north-central Venezuela, we had no idea of the importance of Portachuelo Pass as a migration flyway for birds and insects. Even later on, when we came to compile a list of thirteen life zones within our visual radius, a fourteenth, the Aerial Zone, was added with hesitation, having in mind the inclusion of organisms such as hummingbirds, swifts and mayflies which spend the major part of their lives in midair. Almost immediately, however, the value of and need for such a niche in our phenological program became apparent.

If for no other reason, an Aerial Zone was needed to accommodate the volant organisms which passed and repassed, or occasionally were detected soaring in air, and which were never to be found resting or flying in the jungle of our immediate area of research. Many of these creatures were essentially tropical, occupying our subtropical elevation only as a temporary route of passage.

About 200 meters beyond Rancho Grande, the road leads through a narrow notch in the east-west, coastal Andean range. This is Portachuelo Pass with an elevation of 1,136 meters, about 36 meters higher than Rancho Grande. The flattened floor of the pass is only about 20 meters wide, and the shoulders on either side rise in sharp ridges, 389 meters to the summit of Pico Periquito on the west, and 764 meters on the east to the top of Pico Guacamayo.

The pass is at the 22.5 kilometer mark on the road from Maracay, and, as has been stated, is at an elevation of 1,136 meters. Kilometer 31, well to the north of the pass, is 770 meters above the sea. Kilometer 15, equally distant to the south of the pass and close to the beginning of the lowland savannas, is 760 meters above the sea. At both of these lower stations many migrants have been taken, en route to or on their way from the pass.

The pass is on the real divide, shunting the waters on its northern slope into the

Caribbean Sea, and those on the south side ultimately into Lake Valencia.

Fifteen orders of insects have already been collected or observed as they passed southward on migration, singly, in few or in enormous numbers. Of other possible migrants this leaves only three orders, Ephemerida, Embiidina and Trichoptera. The four parasitic groups, Anopleura, Siphonoptera, Mallophaga and Strepsiptera, are of course absent, although the two latter doubtless hitch-hike through the pass on birds and bees respectively.

The migrating orders, arranged in three columns of relative numbers, are as follows:

Rare	*Moderate*	*Abundant*
Isoptera	Orthoptera	Coleoptera
Neuroptera	Odonata	Lepidoptera
Plecoptera	Homoptera	Diptera
Corrodontia	Hemiptera	Hymenoptera
Thysanoptera		
Dermaptera		
Mecoptera		

Up to the date of this publication, Mr. Henry Fleming has identified two hundred and forty-five species of butterflies, and fifty-two species of day-flying moths. Of the single family of nocturnal moths, Sphingidae, we have recorded seventy-six species, either directly migrating through the pass, or flying about our lights at Rancho Grande. Mr. Fleming has found only two of these which may be classed as breeding in the cloud forest surrounding the pass and our laboratory.

Except for a temporary, limited, northward drift of individual *Phoebis* (*Catopsilia*) in the early part of the rains, the movement of all orders of insects was invariably from north to south through the pass.

Migrating Insects.

Examples of extremes in migration will serve to point up succeeding papers dealing with families and species.

On April 29, 1946, I caught a solitary butterfly at the rim of the pass. Its wing spread was small, and it was an inconspicuous purplish-brown with five spots of dull white near the tip of each fore wing. It belonged to the family Nymphalidae. I gave it the reference field name of Ten-spot Brown and later found its technical name was *Eunica monima* (Cramer).

On May 4, five days later, I caught sight of several butterflies passing overhead and at the pass itself I entered a dense swarm of the Ten-spots. Mingled with them were tailed nymphalids, *Marpesia chiron chiron* (Fab.) in large numbers, and now and then a swarm of large sulphurs, *Phoebis eubule marcellina* (Cramer). In the distance I could see myriads of Ten-spots converging on the pass. One swoop of the net captured seven, five of which were tattered and torn, the remaining two freshly emerged.

Text-fig. 1. Map showing location of Rancho Grande, Portachuelo Pass and surrounding territory.

Two of us climbed a mound giving a view of about half the width of the pass, and here, facing in opposite directions, at eye level, we averaged thirteen hundred butterflies in several counts of four minutes each. At intervals throughout an hour and a half this insect content of a limited time and space remained fairly constant, and when we left we knew that at the very least, two hundred and eighty-six thousand Ten-spots had passed close to us. An hour later the insects were going full strength and now I brought to bear my giant binoculars, first twelve and then twenty powers. I began about twenty-five feet overhead and then refocussed slowly upward until the limit of vision of the small insects was reached. This, judged by horizontal tests of objects of similar size would be about a half mile zenithwards, and at every fractional turn of the screw, more and more smaller-appearing butterflies fluttered into clarity.

Throughout the entire extent of verticality there was no lessening of denseness of flying insects, and it was almost a pure culture of *Eunica* and *Marpesia*. For many days this particular phase of migration continued, millions upon millions coming from some unknown source, travelling due south to an equally mysterious destination.

Three weeks later, on May 24, there was a resurgent migration of the same species, all fresh insects. Their numbers far exceeded the first wave. Four of us lined up across the entire width of the pass, with stop-watches and counters, completely failed

to keep up with fast enough estimate of numbers, but at the minimum clocked a thousand a second going past in the face of a gentle breeze. In the narrow trail above the gorge it was necessary to put on glasses, so dense were the crowds impinging upon our faces.

As the other extreme, I may mention a half hour of collecting when many species in fewer numbers were passing. Twenty successive specimens of butterflies resolved into eleven species of pierids. On another occasion thirteen individual butterflies proved to be thirteen separate species of ithomiids.

Non-recognition of the pass as a flyway accounts for the small number of observations in the year 1946, and the still more meagre and casual notes in 1945. Some time passed before we realized that all of the host of moths which came in windrows to the roof lights and laboratory windows of Rancho Grande were Portachuelo Pass migrants, deflected by confusion of fog or rain. On clear nights of star and moonlight our torches and portable ultra-violet machines revealed unbroken streams of moths of all sizes headed up and through the pass. Other indirect evidences were the wings, belonging to great numbers of species and individuals of moths, found glued in early morning to the dew-moistened leaves of shrubs and weeds in the pass; the remains of nocturnal feasts of marauding bats.

Migration Factors.

One definite factor, which seems the dominant stimulus of migration, is the advent of the rainy season. For example, in 1948, there was no hint whatever of migration in February. On March 1 a single torn and bedraggled nymphalid, *Marpesia chiron chiron,* struggled up to the pass and into my net. Hardly another insect appeared for two weeks, throughout a period mostly cold and overcast. Then, on March 15, a day of warm sun after several days of heavy rain, we caught or recorded twenty species of butterflies in considerable numbers. Succeeding weeks of cold resulted in a complete dearth or mere scattering of insects, until April 15. From this date until August 1 there was no cessation of numbers pouring through, varied only by irregular fluctuations due to occasional days of cold rain or very high wind.

September 9 is the latest date of any of our three years of residence, and on that day migration was in full swing. From what I can learn, the passing insects gradually decrease throughout the succeeding two weeks. On the authority of Dr. Francisco Fernandez, Venezuelan Government Entomologist, diurnal migration at the pass ceased for the year by October 1. The annual picture thus seems clear cut.

The following applies more particularly to diurnal Lepidoptera, but in general is true of all orders:

Inhibiting Conditions: Very high winds, from twenty-five miles per hour upward; chilly temperatures, 62° Fahr. down; dense fog (neblina) or heavy rain; darkness.

Favoring Conditions: Calm, up to a twenty mile per hour following wind; 64° Fahr. plus; sun or thin neblina.

Recurrent Waves: These last from twenty minutes to three weeks, and usually comprise few species (two to twenty), but often large numbers of individuals. These waves are occasionally independent of favorable conditions, the hosts of insects banking up in the lee of brush, waiting for good flying weather.

Between Waves: At these times insects tend to fly singly, and in great variety of species.

Wing Condition: Worn and fresh specimens may be present in the same wave, but as a rule all are worn or all are freshly emerged.

Models and Mimics: Some of the more generally accepted categories of models and mimics may appear mingled together in the waves, or, very interestingly, there are not infrequently pure cultures of each, confined to waves of considerable magnitude.

Specific Characteristics: Normal specific characteristics of flight and of choice of habitat are maintained throughout migration. Rapid or slow flyers do not alter their relative speeds, nor change their dodging, zigzag or direct flight. The same applies as well to high or low habitual levels of flight, fast or slow flapping of wings. Species which prefer to wind their way through low, thick brush adhere to this habit en route up to and through the pass.

Sexes and Breeding: The general rule is the presence of both sexes, and many of the females captured alive deposit eggs within twenty-four hours. Rarely, attempts at mating on migration are observed, or pairs appear to be fighting as they circle rapidly in midair. Very few loiter to feed at blossoms. Few worn individuals stop to rest.

Diurnal Sequence: A few insects, belonging to various orders other than Lepidoptera, appear very early in the morning, for months on end, flying past singly, but in the aggregate in great numbers. Especially noticeable among these are two species of cockchafers (*Cyclocephala* spp.), a chrysomelid (*Diabrotica quindecimpunctata*), a small vespid (*Stalopolybia areata*), a giant hairy scoliid (*Campsomeris ianthina*), and a bee (*Euglossa fasciata*). The numbers of these solitary migrants passing on the morning of June 19, 1948, typifies the numbers on every day for the preceding two months: cockchafers, 200; chrysomelids 150; small vespids 150; giant scoliids 140; rufous bees 90.

Following these there comes, for an hour or longer, a steady procession of day-flying moths, also singly. Butterflies dominate the remainder of the day as far as relatively large insects are concerned. Throughout the

daylight hours there is a continuous passing of migration nekton, hosts upon hosts of minute winged insect life. When dusk gives way to darkness, moths and other nocturnal insects appear, and surge through the pass. If the night is fine, with clear moon or starlight, all continue down Limon Gorge. If the sky is overcast, thick with neblina or rain, the moths leave their direct southern route and detour in tens of thousands to our lighted laboratory windows or white roof walls.

Interpretation: At present, before a detailed study has been made of the mass of specimens and data, and further explorations undertaken of places of origin and destination in surrounding country, no reasonable explanation of this wholesale annual emigration is possible.

Unlike the migration of hosts of *Phoebis* males which I have observed in British Guiana and elsewhere, the Portachuelo hosts are represented by both sexes. Many of the females are ready to deposit eggs, although they are headed away from areas rich in a variety of plants, toward less luxuriant savannas.

The known distribution of many species, or especially subspecies, of butterflies such as the Papilios, shows that their place of origin cannot be very far away to the north and west, but as yet we have no hint of whence the fifteen orders are derived, or whither they are headed. From our own observations, reinforced by the reports of reliable govenment official entomologists, we are certain that little or no migration occurs during the dry season, and that not an insect ever returns to its natal haunts. Hence the phenomenon is really an emigration of the cross section of a considerable volant invertebrate fauna of this part of Venezuela.

Observations during three years confirm the fact that this migration is a regular annual event. It presents the inexplicable problem of a regular abstraction of an appreciable percentage of non-returning population from the area of origin. This implies the leaving behind of an adequate residual number of non-migrants to carry on the race and to sustain future migration.

Sight Identification: When there came recognition of migration on a relatively great scale, our first and indeed continued impulse was to capture as many specimens of as many different kinds as was humanly possible. On an early day of observation a butterfly was taken which, in our mind, was instantly labelled a Monarch, *Danias archippus*, or, if you prefer, *Danaus plexippus*, a familiar of our northern fields. Within an hour eighteen of the same species flapped slowly past, two of them alighting for a few seconds. Within ten minutes there passed eight smaller, darker red butterflies, two of which we took, which vividly reminded us of our northern *Danaus berenice*, commonly called the Queen. Ultimately these two resolved into *Danaus plexippus megalippe* and *Danaus eresimus eresimus*, but throughout my notes, before identification, they were nostalgically recorded as Monarch and Queen. The important thing is that, being easily and accurately recognizable at a distance in flight for what they are, I am able to record, without fear of error, all the numbers that came within my purview, in all my hours of observation at the pass.

This is all by way of introducing the important question of sight identification, which, in any research such as the present, must play a dominant part. I based all my field naming first, on captured and ultimately precisely named specimens, and secondly, on characters in flying or resting insects which left no shadow of doubt. Although hundreds and tens of thousands of insects passed with only the vaguest hints of family or genus, yet day after day familiarity introduced to the perception characteristics of flight, pattern, color and shape of wings, and general facies, which materially increased range and certainty of recognition.

Viewing from a distance of ten meters, groups of species mounted in open cases, proved an excellent check on visual awareness of distinctions. A brief treatment of sight identification will be added to each paper dealing with families of insects.

This and following papers are intended only as factual presentations of notes made during three seasons of observations of migration from north to south through Portachuelo Pass. Hence no attempt has been made at correlation or even mention of migrations of the same or related species observed by entomologists elsewhere. The insects themselves will be considered group by group in successive papers, with a final summary in detail of the migration as a whole.

We hope, in future expeditions in this same field, that data will be obtained which will clarify the place of origin and ultimate destination of the insect hosts, as well as the initiating stimuli and directive factors of their migration.

An account of the bird migration through the pass has already appeared, treating of sixty species divided among ten types of migration.[2]

EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. Looking south toward Portachuelo Pass from Kilometer 31.

Fig. 2. Portachuelo Pass, the notch in the distant sky-line, from farther north, near the sea.

Plate II.

Fig. 3. Migrant insects alive but quieted by refrigeration.

Fig. 4. Migrant moths deflected in great numbers, on nights of storm, from their migration through the pass, to the electric lights on Rancho Grande roof.

[2] *Zoologica*, 32 (18), 1947, pp. 153-168.